Can. Pam. MacKellar, Peter. T

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The Gold-Bearing Veins of Bag Bay, Near Lake of the Woods.

BY PETER MACKELLAR, F.G.S., FORT WILLIAM, ONTARIO, CANADA.

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INTRODUCTION.

THE district around Bag bay in Shoal lake, west of Lake of the Woods, in the Ontario western gold-fields, is attracting considerable attention at the present time as a gold-producer. A large number of gold-bearing veins have been prospected and mined to a considerable extent in the locality. On the whole they make a fair showing, considering the work done; and some are undoubtedly rich—the Mikado, for instance. The principal mining companies that have been operating here are the Yum-Yum, Ontario Limited, Cornucopia, Engledue Concession, Tycoon, Toronto and Western and Mikado Cos. I will confine my remarks chiefly to the three companies last mentioned, as their developments, lying in the Bag bay granite (which is several square miles in extent), present the peculiar feature which this paper is intended to describe, namely, the smallness of the quartz-fissures as compared with the size of the ore-bearing lodes. Most of the operations of the other companies are within Huronian areas, and if the veins which they are working were formed under similar conditions, as I think they were, the peculiarity referred to is not so strongly marked.

THE GEOLOGICAL FORMATION.

The geology of the western gold-fields of Ontario has been fairly well established by the Canadian Geological Survey and the Ontario Bureau of Mines. Dr. Bell commenced the real work in the Thunder Bay District in 1869 and in the Wabigoon and Lake of the Woods Districts in 1881, and made the first geological map of these regions. He showed that the rocks belong to the Archæan age, which comprises the Laurentian

and Huronian systems. The gneisses and the principal acid eruptives were classed as Laurentian; while the green schists in general, and the basic eruptives, were provisionally included with the Huronian.

The work was ably continued by Messrs. A. C. Lawson, W. McInnis, W. H. Smith and others. Now the whole district from Thunder bay to the Manitoba boundary, a distance of more than 300 miles, is pretty thoroughly mapped out, so as to show its principal geological and topographical features. Through the gneisses and schists, granite, syenite, protogine, etc., have been erupted in great bosses and irregular areas. These, again, have been intersected by dikes of felsite, diorite, etc., and, still later, by numerous fissure-veins, which, in many localities, are gold-bearing.

Mining Developments.

The Mikado Mine.—The well-known Mikado gold-mine is situated on the south side of Bag bay. It has been in successful operation with a 20-stamp mill during the last eighteen months. Three veins on the property, Nos. 1, 2 and 3, are worked. In the report of the Ontario Bureau of Mines for 1898, page 53, Mr. Breidenbach, the general manager of the company, reports as follows:

"On No. 3 vein the shaft has been sunk 45 feet and is being continued. It has enlarged from several inches at the top to 5 feet at the bottom, and the assays run from $1 per ton at the surface to $7 at the bottom, increasing gradually. . . . . No. 1 and No. 2 veins have been mined to a depth of about 250 feet each. No. 2 vein, at the surface, is only 2 to 3 inches wide of quartz, but rich—$100 to $200 to the ton. At a depth of 100 feet the lode is 6 feet wide, of $10 per ton ore—principally the green veinstone, mikadoite, to be described further on. At 240 feet deep the lode is larger, 6 to 12 feet wide and $15 to $20 to the ton."

I have confirmation of these particulars from reliable sources. No. 1 showed an unusually large outcrop of quartz for this class of veins. It was a high-grade ore, $45 or more to the ton.

During surface-developments, the ore was believed to be free-milling, and only amalgamated copper plates were used for saving the gold. About two months ago, the erection of a cyanide plant with a capacity of 50 to 60 tons per day was commenced. It was completed about the middle of November last. It has been installed by Mr. J. C. Pengilly, a gentleman

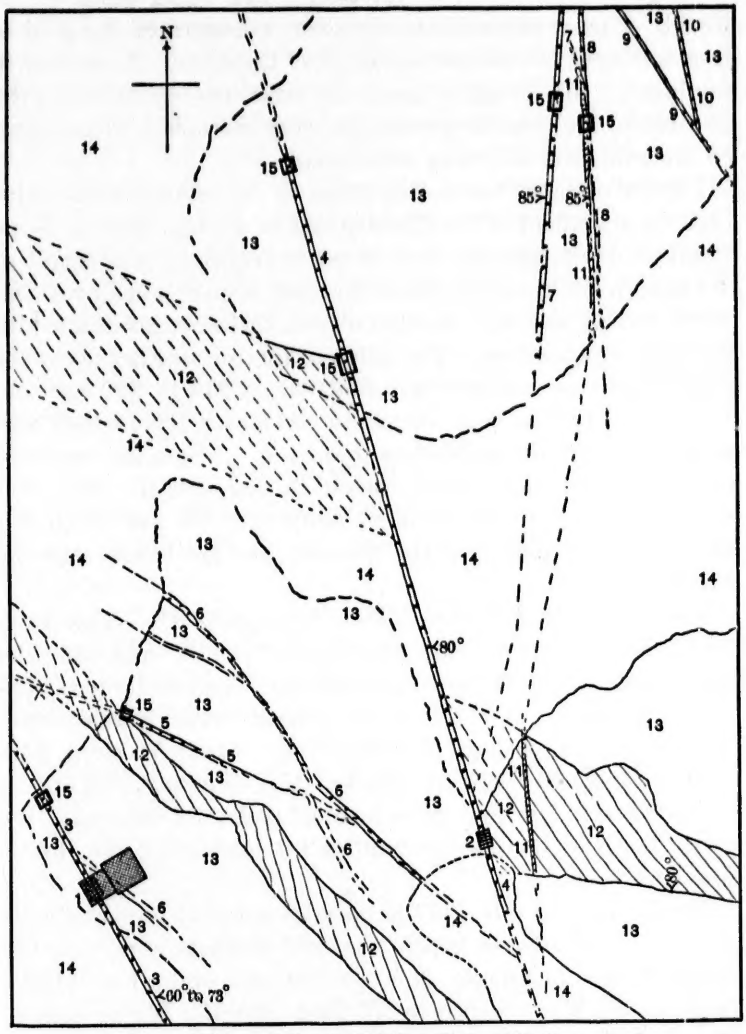
of large experience in South Africa and other parts of the world. Now it seems that only about one-third of the gold is free-milling in the deeper workings of the mine. In answer to my inquiry, Mr. Pengilly kindly informed me by letter that the first run of the cyanide process was very successful, 77 per cent. of the gold-contents being recovered.

I know no more convincing proof of the value of these veins than the statement of Mr. Breidenbach in the Rat Portage *News*, about six weeks ago, that there was a twenty-five years' supply of ore in sight in the mine, which has not been worked over two years, during eighteen months of which time a 20-stamp mill has been in operation. The value of the ore worked up to the present date, as near as I can find out, is $15 to $20 per ton. Very rich ore has been struck in the lower level which will average many thousand dollars to the ton. When last reported they had taken out several tons of it, and still the body was getting larger. I have handled samples of the ore which felt heavy with the gold, like the Calumet and Hecla ore, with its native copper.

The Toronto and Western Mines Development Co.—This company owns the Sirdar mine, on location "D 410," adjoining the Mikado mine on the east; also several other contiguous locations, "D 411," "D 412," etc., all situated on the granitic area, and many other locations throughout the Ontario Western gold-fields. As Field Superintendent of this company, and also as connected with its development-work for the last two years, the writer has had many opportunities for examining the formations and veins.

The Sirdar and "D 411" properties are each one-half mile square. On the latter location several test-pits were sunk on different veins to a depth of 5 to 8 feet each and a 7 by 11-foot shaft was sunk to a depth of 57 feet. On the Sirdar several veins have been examined by sinking test-pits to a depth of 5 to 8 feet, and two shafts have been sunk, one on No. 1 vein to a depth of over 100 feet (now in progress of development with a steam hoist), and the other on No. 2 vein to a depth of 57 feet. The veins occur in groups, one of which appears on "D 411" and two on the Sirdar location. Of the latter, Fig. 1 shows the western one, Group A. These veins appear on the surface like stringers of quartz, rarely reaching a width of more than

FIG. 1.



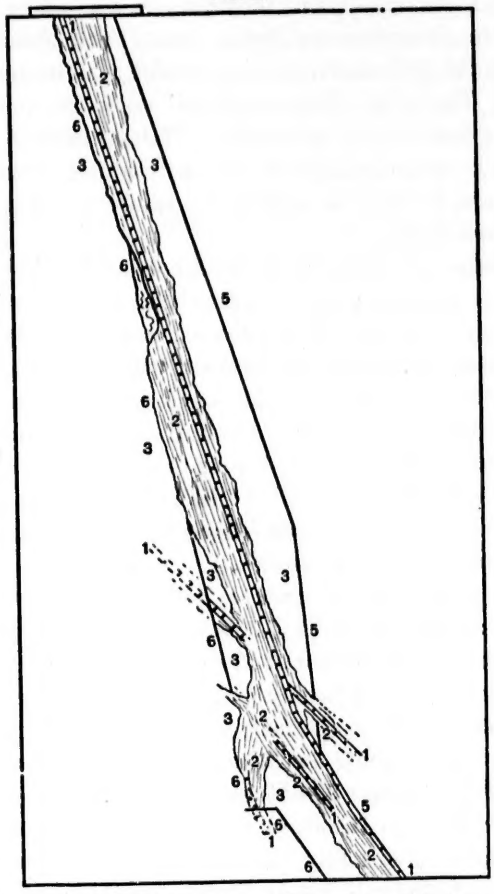
Group of Veins, Sirdar Gold Mine, Scale 1650, linear, to 1.

1. Shaft and shaft-house on No. 1 Vein. 2. Shaft on No. 2 Vein. Shows lateral trough of over 200 feet. 3. No. 1 Vein. 4. No. 2 Vein. 5. Veins, 3 in. quartz and 2 to 3 ft. mikadoite. 6. Quartz stringers with mikadoite. 7. Vein No. 3, Quartz 4 to 10 in. and mikadoite 5 ft. 8. Vein, 3 to 4 in. quartz; 2 to 3 ft. mikadoite. 9, 10. Quartz veins, 4 to 5 in. wide. 11. Chloritic-diorite dike, 4 to 12 in. wide. 12. Felsite dikes. 13. Granite. 14. Covering of alluvial deposits. 15. Test-pits.

six inches. They are traced with difficulty for any great distance along the surface, yet when opened up by mining they

generally show two, three, six or more feet in width of gold-bearing ore, a greenish veinstone which I will call mikadoite for convenience of description in this paper. This veinstone seems to be a talco-siliceous mineral resembling sericite. It

FIG. 2.



Vertical Section of Shaft on No. 1 Vein—Scale 240, linear, to 1.
1. Quartz vein. 2. Mikadoite. 3. Granite. 5. Hanging-wall of shaft. 6. Foot-wall.

appears to have been formed by the alteration of the granite. Its color is greenish-white to green; it is massive and slightly unctuous, and merges into the quartz as if they were one mineral. When light in color it is called quartz by the miners and

others generally, but it is easily detected by its yielding readily to the knife and leaving a white powder. It first became conspicuously noticeable in the Mikado mine, and it forms the principal productive portion of the gold-veins in the Sirdar group. All these veins upon which work has been done are much alike in character, but they vary in size and richness.

Quartz, in irregular stringers, lenses and lumps, occurs throughout the mikadoite, more plentifully in some parts than in others. There are also occasional stringers of dark-green chlorite, one-half to one inch wide. The mikadoite penetrates the granite in several places in the shaft which are not marked in the section, as only the outshoots, where I had taken measurements, are shown.

The shaft is now down to the 100-foot level. At the surface the principal sheet or vein of quartz was on the foot-wall, with the mikadoite above it. It continued on a straight line, at the dip of 73 deg., to a depth of 85 feet, with a strongly marked wall. At this point the mikadoite is below it, and more than seven feet wide. At 60 feet depth there was about 1 foot of mikadoite above and 3.5 feet below the quartz sheet or vein. The latter varies from a couple of inches to four or five inches in width. The amount of vein-quartz through the mikadoite is irregular and varies considerably.

The ore in bulk in the upper portion of the vein, chiefly mikadoite, averaged about $4 per ton, as was shown by a test of about 45 tons treated at the Keewatin reduction works. Again, by sampling a pile of about 30 tons of the ore taken from a depth of 65 to 80 feet, and another pile of 25 tons from a depth of 80 to 90 feet, the yield on assay was found to be $4 in the former and $24.20 in the latter. The assays were made by Mr. Charles Brent, of the Rat Portage metallurgical works. I have made many pan-tests of the ore from this shaft, and have found the gold much coarser from the lower part than from the upper. It does not appear that there is much change in the richness of the pure quartz; but the mikadoite seems to improve very much in value below the depth of 70 to 100 feet. The work in the Sirdar and Tycoon mines shows this, and I have reliable information that this mineral is much richer in the lower part (below the 100-foot level) than it is in the upper part of the Mikado No. 2 vein. I may also mention that sam-

ples of mikadoite from the Sirdar shaft, below 80 feet in depth, assayed in Toronto, gave more than $300 to the ton.

The Tycoon Mine.—This property is a water-location of about 60 acres, enclosing three islands in Bag bay, immediately in front of the Mikado and Sirdar mines. It lies across the strike of the veins of the Mikado and of those of group A of the Sirdar. On these islands three diamond-drill holes were sunk to vertical depths of 108, 128 and 152 feet respectively, and each intersected a group of veins. Mr. James Conmee, M.P.P., kindly showed me the results of the borings, which confirm to a remarkable degree the impressions I had formed as to the principles governing the formation of these veins. The vein outcrops would be passed over as unworthy of notice even by mining prospectors, unless they had previous knowledge of this class of veins. Only small veins of pure quartz are shown; and the greenish veinstone, or mikadoite, which accompanies the quartz differs but slightly in appearance, on weathered surfaces, from the granite. The surface-samples I have panned showed very little gold; and yet, below the 100-foot depth, where the diamond-drill cut the veins, they are very rich, as will be seen by the description given below.

I expected a fair showing of gold at the depths where the drill would intersect the veins, by reason of the results of the developments obtained on shore; but I had no expectation of such a remarkable showing as the actual tests presented. The first bore-hole, at a depth below 120 feet, intersected a vein 11 feet wide, which assayed an average of $19 per ton. It then passed through 24 feet of granite and intersected another vein-belt, 20 feet wide, that assayed an average of $13 per ton. The second bore-hole was placed about 300 feet east, to intersect a second vein. This hole passed through two vein-belts separated by 46 feet of granite. The first belt is 60 feet wide, of siliceous schist, or mikadoite, assaying $4 per ton. Within this schist are seven quartz-veins, each 1.5 to 4 feet thick, an aggregate of 19 feet of quartz, which yielded by assay an average of $67.25 per ton. The whole width of the vein-belt, 60 feet, gives an average of $24.10 per ton. After passing the granite, a second vein-belt is reached. This is 20.5 feet wide, and gives an average assay of $37.65 per ton. One branch of quartz in this belt, 4.5 feet wide, averaged $150 per ton; another, 6 feet wide, gave $7 per ton, and the balance $5.50 per ton.

The third hole reached a vertical depth of 108 feet. The first vein-belt intersected was 26 feet wide and assayed $6.70 per ton; the second vein-belt, below the 100-foot level, was 6 feet wide, and assayed an average of $16.50 per ton.

Vein-Characteristics.

These veins consist of small quartz sheets with comparatively large quantities of the altered granite (mikadoite) which shows a schistose structure next to the quartz, and passes by gradual transition into massive granite. It is generally charged with fine iron pyrites amounting to 0.5 to 3 per cent., and carries more or less gold, in grains and not in leaves, as it is in the quartz in some places. Small quantities of the sulphides of copper, lead, zinc and bismuth are occasionally present, more particularly in the quartz, rarely in the mikadoite. The latter accompanies the quartz fissure-veins and spreads out irregularly to either side, apparently following lines of weakness or lines along which the granite was most numerously jointed, and thus forms great bodies of ore. The veins are shown to be true fissures by the faultings of the formations. Along No. 2 vein, Fig. 1, the felsite dike is displaced laterally over 200 feet. Again, they intersect alike the massive and stratified formations.

The felsite dikes are charged more or less with gold adjacent to the quartz-veins without being otherwise much altered, except that they have an increased percentage of iron pyrites. Samples taken at the surface from the felsite dike cut by Sirdar No. 2 vein yielded by assay over $6 per ton, and pan-tests of the same at the depth of 50 feet were much richer; but this dike has not been tested with a view of finding how far the gold penetrates into it. Some of the smaller dikes that traverse the Huronian strata are gold-bearing also. Several of these, which intersect the diabase masses, are being mined with promising results. For instance, Inspector Bow, in the seventh report of the Ontario Bureau of Mines, says, in regard to the Ontario Limited mine, that No. 4 vein appears to be a felsite dyke; that it has been traced for 500 feet, and shows in one place where it has been uncovered a width of 12 to 14 feet; also, that a test-pit has been sunk 9 feet upon it, and a quantity of ore has been taken out for a mill-run. Again, in reference to the Gray Eagle mine, he says (p. 59) that the ore-bodies are large felsite dikes which contain a few stringers of quartz.

The Source of the Gold.

It seems highly probable that the gold was derived from heated vapors and solutions that ascended through the fissures from great depths, presumably from the vicinity of the magmas, the source of the felsites and greenstones. The felsite dikes are generally present near the veins, and are usually more or less charged with the fine-grained sulphide of iron that almost invariably accompanies the gold in the veins. They are also frequently auriferous, and especially so in the near vicinity of quartz veins. The felsite in many places loses its visible texture and passes into phonolite with the usual metallic ring. It is probable that this rock has some connection with the presence of the gold here, as I understand the phonolites of the famous Cripple Creek are admitted to have in that region. And, somewhat similarly, the trappean eruptions are connected with the presence of the Lake Superior native copper. For these reasons I have great confidence in the continuance and improved value in depth of the auriferous veins just described.

Principles of the Vein-Formation.

In my examination of these veins I was for a long time unable to understand the nature of their formation, nor did I find the conditions presented to agree with the ordinary fissure-vein theories of which I had any knowledge. I came at last to the conclusion that, during the movements that caused these rents, a sufficient pressure was exerted to prevent such a separation of the walls as would leave an opening or gap for the reception of vein-matter. Therefore the opening must have been created afterwards. There can be no doubt that the rock masses which were involved in creating the fissures must have been enormous, and that the granulation and lamination of the walls would be a natural consequence. Subsequently the heated solutions that would surely percolate among the fissures and interstices would be likely to dissolve the more granulated portions for the reception of the silica or usual vein-quartz, while the other crushed portion would be metamorphosed, as is well represented by Professor C. R. Van Hise in his admirable paper on "Metamorphism of Rocks and Rock-Flowage."

Again, Dr. M. E. Wadsworth, President of the College of

Mines, Houghton, Mich., says, in his pamphlet on the Lake Superior Copper Deposits, 1891:

"One of the latest phases of the formation of deposits of value has been the filling in of fissures by the water-deposited quartz and other vein-materials, or, in case no crack nor fissure existed, by the removal of the country-rock along certain lines and their replacement by vein-matter."

I have noticed a great difference in the character of these gold fissure-veins of Archæan times, and those of later age, such as the silver-bearing veins of Thunder bay. The latter show well-defined walls, frequently with brecciated extraneous matter enclosed in the quartz or sparry matrix, while the adjacent rocks are but slightly, if at all, laminated or metamorphosed. The veins in the Archæan rocks, on the other hand, rarely show two well-defined walls and seldom contain extraneous brecciated matter, and the adjacent country-rock is generally laminated and highly metamorphosed. The laminated portions are, in many places, an important factor in the gold-veins of the latter class, as shown by these of Bag bay. There may be veins of later age within the Archæan areas, but there cannot be any of Archæan age in the areas of newer rocks. I believe that the gold-veins of the western Ontario gold-fields were formed in Archæan times, as I know of no place where they penetrate the later formations around the basin of Lake Superior. They occur in the Archæan areas on both sides of the lake, as at Jackfish bay, at Schreiber and on Shebandowan lake on the north side, and again at the Ropes gold-mine, north of Ishpeming on the south side, but not in the later rocks which lie between the last-mentioned and the others. Although it does not appear that there are gold-veins in the newer rocks (Cambrian and Silurian) in the Lake Superior country, it is in rocks of later age than the Archæan that gold is chiefly found in other parts of the world.

Sawbill and Hammond Reef.

I believe that many other localities throughout this vast area of gold-bearing rocks in the western Ontario gold-fields will be found to be subject to similar geological conditions in regard to vein-formations. I will only refer to one locality which lies along the Seine river in the vicinity of Sawbill lake. I have

spent considerable time in exploiting the gold-veins in that district. The rocks are somewhat similar to those at Bag bay, and consist of Huronian strata and eruptive rocks. The principal eruptive is an altered granite or protogine, in which chlorite takes the place of mica. I noticed in several of the quartz-veins here the same greenish siliceous veinstone (mikadoite) as that in the Bag bay veins; and it is also auriferous in many places.

It seems probable that the granitic rocks of these two localities were erupted from the same or analogous magmas at about the same geological time. At both places they are intersected by similar dikes of felsite and diorite. Out of many auriferous lodes here, I will refer only to one, the well-known Hammond Reef. This is a remarkable gold-bearing belt. It is 100 to 500 feet in width, and traverses the country for miles, separating into branches that diverge at considerable angles. The gold-bearing portions are largely mikadoite, with branches of quartz. It seems to have been formed under similar conditions to those of the Bag bay veins. Here there appears to be a series of nearly parallel fractures, close to each other. The mechanical forces that were in action were not equal to reducing the whole to a sufficiently crushed condition to be effectively acted upon by the heated solutions. Hence the unreduced portions appear as enclosed barren cores within the reef. According to the hypothesis explained above, the reefs or lodes should improve in depth.

Peculiarities of the Archæan.

As I have endeavored to point out, these Archæan metalliferous deposits are different from the general metalliferous formations of the world, and it appears to me that the gold-bearing fissure-veins are marked examples characteristic of the former.

Considering the early age of the Archæan rocks in the history of the globe, the crust at that time must have been thinner and weaker, the heat greater, the gaseous elements more powerful, and the shrinkage of the crust more rapid and intense, than in later times. Therefore, it might be expected to find the rock-formations greatly fractured, and the sides of the rents ground and laminated to a greater extent than in veins of later date. Although there may be veins of the open-spaced

fissure-kind here, I think the majority are of the other variety, in which the space for the reception of the vein-matrix was created by solvents in the water circulating through the crushed material along the fractures. In the latter case, the size of the quartz-vein is not a fair standard of the strength, value or continuity of the lode, when judged by the principles of formation and filling of fissure-veins of later formation. The lamination of the walls is, I think, a guide by which to distinguish the two kinds of veins. I am strongly of the opinion that mining men and experts in general will be mistaken if they look for the general characteristics of the open fissure-vein among the Archæan rocks of the western gold fields of Ontario.

In conclusion, I may say that the doubts which existed about the continuance downwards of the gold-deposits in these Archæan rocks have about vanished within the last two years. I think that, upon consideration of the showing made here, it will be conceded that the auriferous deposits of the western Ontario gold-fields promise to improve in depth—more, probably, than those of any other gold-mining country in the world. The deeper into the veins, the more effective should have been the crushing and granulating process; and, proportionally, the quantity of both quartz and mikadoite ore should be greater also.